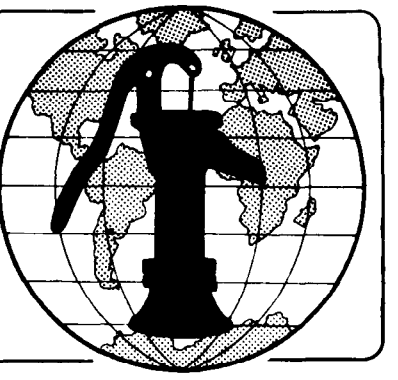
Water for the World

Designing Pits for Privies

Technical Note No. SAN. 1.D.2.



Designing a pit for a privy involves selecting its location, calculating its size, and determining the labor, materials, and tools needed for construction. The products of the design process are: (1) a location map, (2) technical drawings of the pit, (3) sketches of the pit lining, if needed, and base for the slab, and (4) a materials list. These products should be given to the construction supervisor before construction begins.

This technical note describes how to design a pit and arrive at these three end-products. Read the entire technical note before beginning the design process.

Useful Definitions

DECOMPOSE - To decay and become reduced in volume due to bacterial action; this happens to excreta in a pit.

IMPERVIOUS - Not allowing liquid to pass through.

PERMEABLE - Allowing liquid to soak in.

Materials Needed

Measuring tape - To obtain accurate field information for a location map.

Ruler - To draw a location map.

Location

The major factors in selecting a location for a privy are: (1) location of water supplies, dwellings, and property lines, (2) soil type, (3) groundwater levels, and (4) impervious layers.

Location of Water Supplies, Dwellings, and Property Lines. A pit privy should be downhill from water wells. It should be at least:

20m from the nearest well or stream,
6m from the nearest dwelling,
3m from the nearest property line.

For the sake of convenience, the privy should be no farther than 30m from the building to be served. It should be on fairly level ground. When a proposed site has been selected, determine the soil type.

Soil Type. A pit should be dug in permeable soil so the liquid part of the excreta can soak into the ground. The rate at which liquid soaks in depends on the type of soil. If the rate is too fast or too slow, the soil is not suitable for a pit. The main types of soil are sand, sandy loam, loam, silt loam, clay loam, and clay. For a detailed description of soil types see "Determining Soil Suitability," SAN.2.P.4.

When the soil at the pit site has been identified, use the following chart to determine its suitability.

Table 1. Soil Suitability

Soil Type	Suitability
Sand	No
Sandy Loam	Yes
Loam	Yes
Silt Loam	Yes
Clay Loam	No
Clay	No

If the soil is not suitable, select another location for the pit. If no good location can be found, design an alternative excreta disposal system (see "Simple Methods of Excreta Disposal," SAN.1.M.1). If the soil is suitable, proceed to the next step.

Groundwater Levels. The bottom of the pit must be at least 1m above the groundwater level during the wettest season of the year. This information may be available from local residents, water well owners, or water well drillers. If the information is not available or reliable, field tests must be made. These tests are described in detail in "Determining Soil Suitability," SAN.2.P.4. In brief, a hole must be dug 1m deeper than the proposed pit. Dig the test hole during the wet-test season. If no groundwater is observed, groundwater levels are suitable.

If groundwater levels are not suitable, select another location for the pit. If no acceptable location can be found, design an alternative excreta disposal system (see "Simple Methods of Excreta Disposal," SAN.1.M.1).

Impervious Layers. The bottom of a pit must be at least 1m above impervious layers such as creviced rock, hardpan, shale, or clay. The same test hole dug for determining groundwater levels can be used to check for impervious layers. If there are impervious layers in the test hole, the site is unacceptable for a pit and a new site must be found. If no suitable site can be found, design an alternative excreta disposal system (see "Simple Methods of Excreta Disposal," SAN.1.M.1).

When a suitable site has been found, draw a location map similar to Figure 1, showing the pit site and distances to water supplies, streams, dwellings, property lines, and any other nearby structures or prominent geographical features.

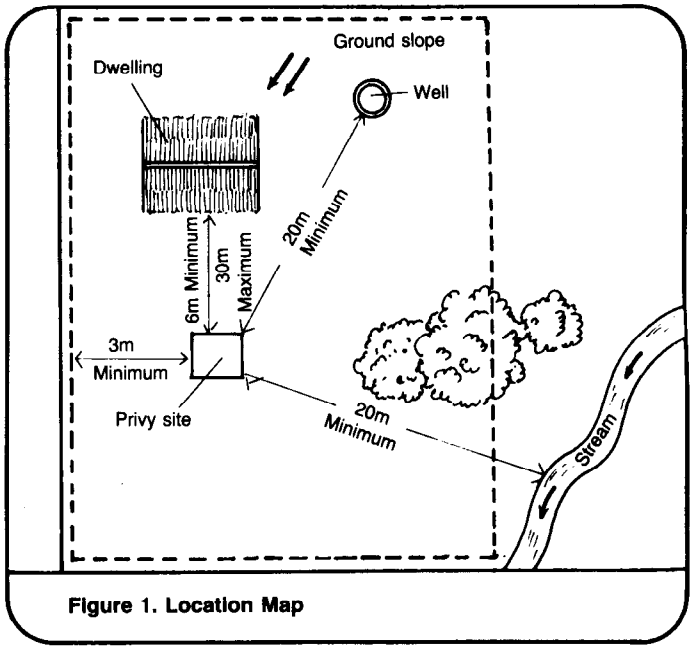


Figure 1. Location Map

Determining Pit Size

To determine the length, width and depth of a pit, first calculate the capacity. The capacity, or volume, of a pit is determined by the number of users of the privy, the number of years the pit is expected to last, whether the privy will have a pour-flush bowl, and the type of anal cleansing material used. Worksheet A shows a sample calculation of the size of a pit.

The number of users equals the number of persons living in or using the building to be served (Worksheet A, Line 1).

The pit should be designed to last 5 to 10 years, preferably 10 (Worksheet A, Line 2).

If the privy will have a pour-flush bowl, the pit can be smaller because the water used to flush the bowl will cause the excreta in the pit to decompose more rapidly (Worksheet A, Line 4).

The capacity of the pit is calculated as follows:

For a pit without a pour-flush: number of persons times number of years times 0.06 equals volume in cubic meters (Worksheet A, Line 5).

For a pit with a pour-flush: number of persons times number of years times 0.04 equals volume in cubic meters (Worksheet A, Line 6).

Worksheet A. Calculations for Privy Pit, Lining, and Base

Capacity of Pit

1. Number of users = 6
2. Designed life of pit in years = 8
3. Line 1 x Line 2 = 48
4. Is there a pour-flush bowl? [x] no [ ] yes
5. If "no," then Line 3 x 0.06 = 2.8 m^3
6. If "yes," then Line 3 x 0.04 = _____ m^3
7. Do anal cleansing materials readily decompose? [x] yes [ ] no
8. If "yes," then capacity = Line 5 (or Line 6) = 2.8 m^3
9. If "no," then capacity = 1.5 x (Line 5 or Line 6) = _____ m^3

Dimensions of Pit

10. Capacity (from Line 8 or Line 9) = 2.8 m^3
11. Pit is for (check one): [ ] pit privy [x] ventilated pit privy
    [ ] offset pit privy
12. Width (from Table 2) = 1.1 m
13. Length (from Table 2) = 1.2 m
14. Line 12 x Line 13 = 1.32 m^2
15. Depth = $\frac{\text{Line 10}}{\text{Line 14}}$ = 2.1 m

Quantity of Lining Material (area of pit walls)

16. 2 x Line 12 = 2.2 m
17. 2 x Line 13 = 2.4 m
18. Line 16 + Line 17 = 4.6 m
19. Area of walls = Line 15 x Line 18 = 9.7 m_2

Distance Around Pit (periphery)

20. Periphery = Line 16 + Line 17 = 4.6 m

Volume of Poured Concrete Base

21. Width of base = 0.15 m
22. Thickness of base = 0.05 m
23. Volume = Line 20 x Line 21 x Line 22 = 0.03 m^3

Lengths for Wood or Log Base

24. Line 12 + 1.0m = 2.1 m
25. Line 13 + 1.0m = 2.1 m
26. Lengths of the four logs or wood beams:

    (1) Line 24 = 2.1 m
    (2) Line 24 = 2.1 m
    (3) Line 25 = 2.2 m
    (4) Line 25 = 2.2 m

Example 1. Suppose a pit privy without a pour-flush is being designed for a family of six and is to last eight years. Then the capacity of the pit equals:

6 x 8 x 0.06 = 2.8 cubic meters (Worksheet A, Lines 1-5).

Example 2. Suppose a pit privy with a pour-flush is being designed for a family of six for eight years. Then the capacity of the pit equals:

6 x 8 x 0.04 = 1.9 cubic meters (Worksheet A, Lines 1-6).

If anal cleansing materials that do not readily decompose such as grass, leaves, corncobs or mudballs are used, the capacity of the pit should be multiplied by 1.5 (Worksheet A, Line 7). For example, if the capacity of the pit was calculated to be 3.0 cubic meters and corncobs are the usual anal cleansing material, the required capacity of the pit is:

$3.0m^3$ x 1.5 = 4.5 cubic meters (Worksheet A, Line 9).

When the capacity has been calculated, determine the dimensions of the pit. First, find the length and width. They depend on the type of slab and shelter being used (see "Designing Slabs for Privies," SAN.1.D.1 and "Designing Privy Shelters," SAN.1.D.3).

In general, a pit for a privy is square and is directly beneath the slab and shelter. A pit for a ventilated pit privy is either slightly offset or slightly longer than it is wide to accommodate the vent pipe. A pit for an offset pit privy is longer than it is wide and larger than a pit that is not offset.

(NOTE: A pour-flush bowl is generally used with a ventilated pit privy or an offset pit privy.)

Table 2 shows the general width and length and the minimum depth of the pit for each type of privy.

Determine the correct depth by dividing the design capacity by the width times the length (Worksheet A, Lines 10-15).

Table 2. Privy Type and Pit Dimensions

Privy Type	Pit Dimensions		
	Width	Length	Depth
Pit Privy	1.0-1.2m	1.0-1.2m	at least 1.5m
Ventiliated Pit	1.0-1.2m	1.1-1.5m	at least 1.5m
Offset Pit	1.0-1.2m	1.5-2.0m	at least 3.0m

For example, calculate the correct depth of a ventilated privy with a capacity of 2.8 cubic meters, a width of 1.1 meters, and a length of 1.2 meters.

$$\text{depth} = \frac{2.8m^3}{1.1m \times 1.2m}$$

$$= \frac{2.8m^3}{1.32m}$$

$$= 2.1m$$

For pits 2.5-3.5m deep, add 0.15m to the length and 0.15m to the width to accommodate a step or ledge left in the walls during construction. For safety reasons, do not design a pit to be dug by hand deeper than 3.5m.

When the dimensions of the pit have been determined, make a technical drawing similar to Figure 2 showing length, width, and depth. For an offset pit privy, which requires a chute from the squatting slab to the pit, make a drawing similar to Figure 3 showing length, width, and depth of pit, and excavation for the chute. Give these drawings to the construction supervisor.

If the soil is such that the walls of the pit will not stand on their own in both the wet and dry seasons, the pit must have a lining. All pits need a base to support the slab (see "Designing Slabs for Privies," SAN.1.D.1).

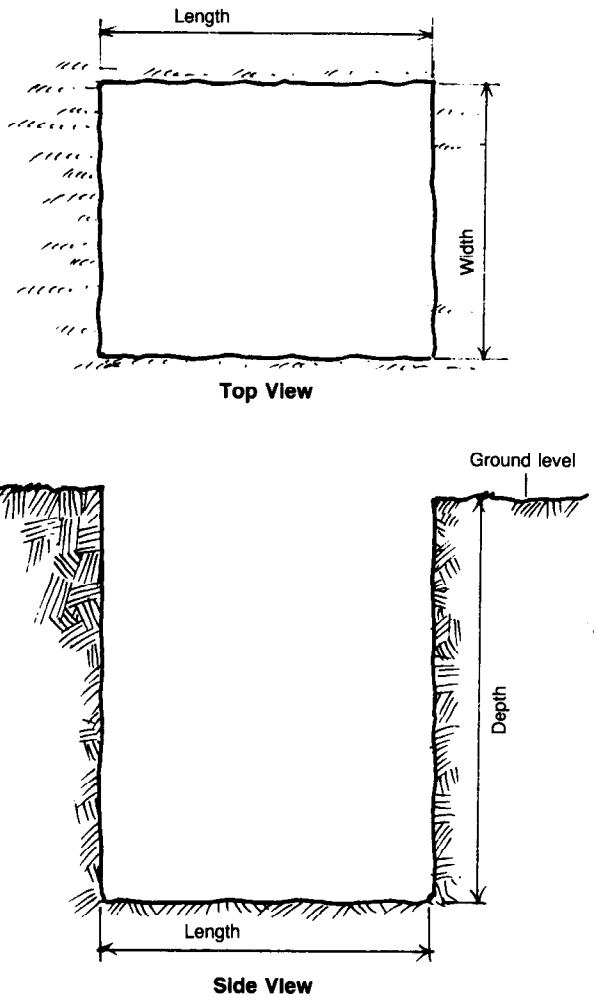


Figure 2. Dimensions for Pit Privy or Ventilated Privy

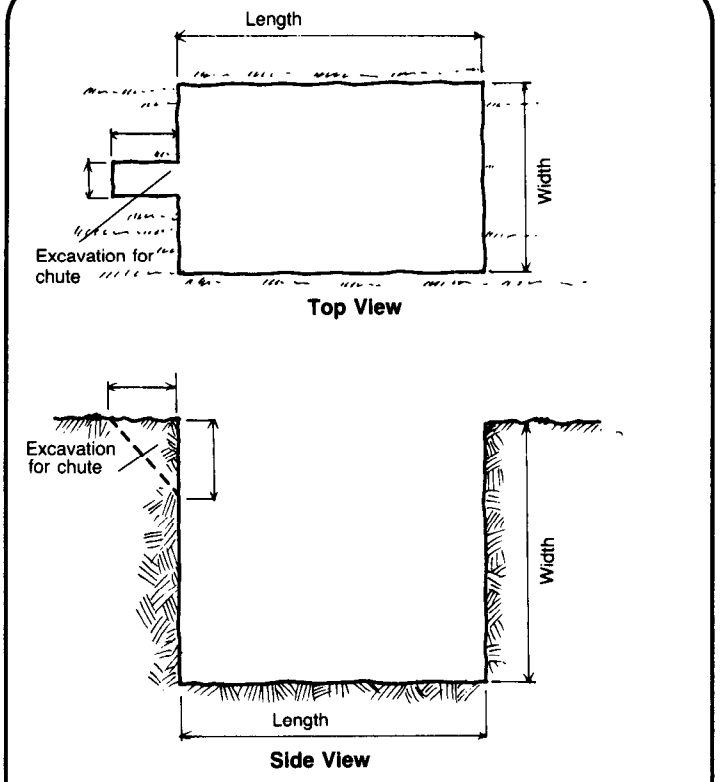


Figure 3. Dimensions for Offset Pit Privy

Caution!

Before the pit is excavated, design and construct the slab or, if it is an offset pit, the cover (see "Designing Slabs for Privies," SAN.1.D.1 and "Constructing Slabs for Privies," SAN.1.C.1). This is necessary so that when the pit is constructed, it can be covered immediately. A pit left open and unattended is a serious hazard. Whenever workers leave the site, they should cover the pit with the slab.

The lining can be made of bamboo, logs, poles, boards, bricks, concrete blocks, or select field stones. Whatever material is used, it must have slits or open spaces to allow the liquid part of excreta to pass through to the soil. For an offset pit privy, a space must be left in the lining to allow for the chute.

Prepare a sketch similar to one of those in Figure 4 showing the lining material and a sketch similar to one of those in Figure 5 showing the materials to be used for the base, and give both of them to the construction supervisor.

Materials List

Prepare a materials list similar to Table 3, showing labor requirements, types and quantities of materials and tools, and the estimated funds needed to construct the pit, including lining and base. This technical note provides the means of determining some quantities. The remaining quantities will have to be determined by you as the project designer or by the construction supervisor.

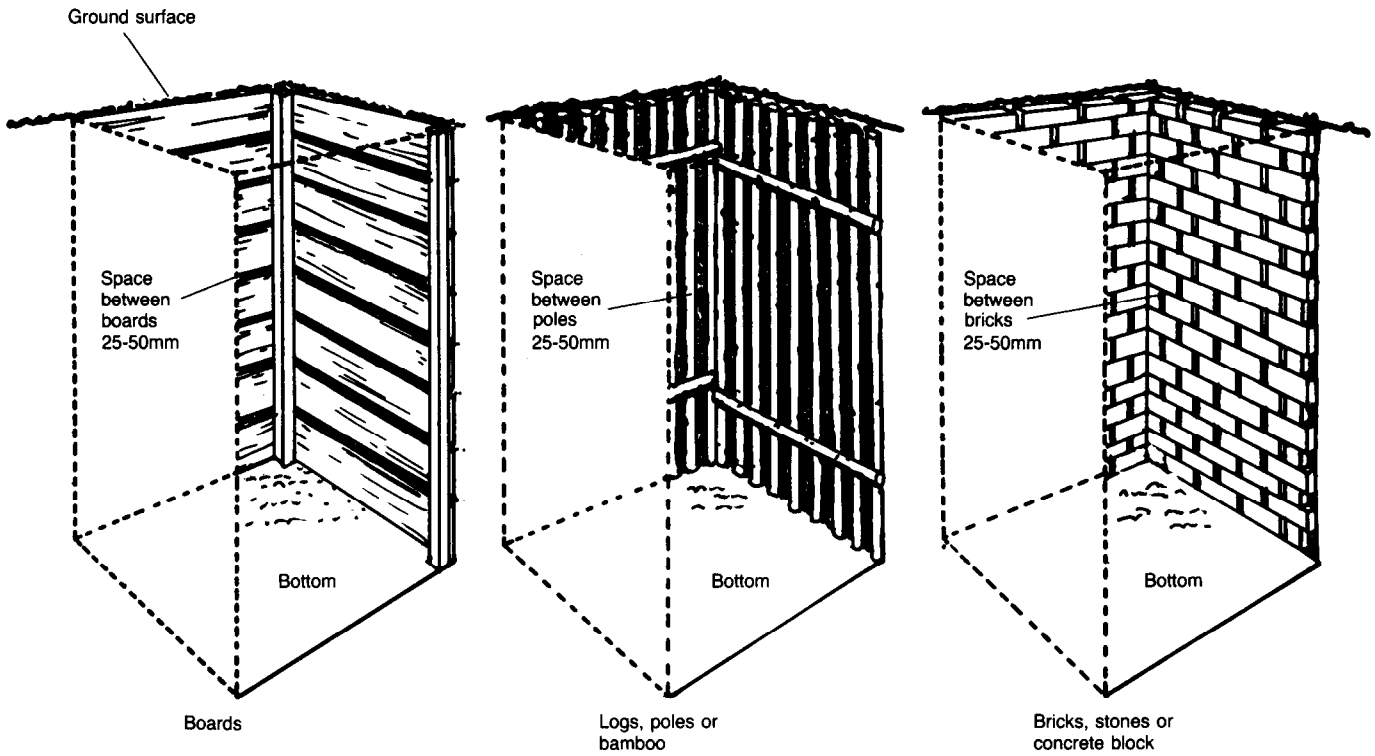


Figure 4. Pit Linings

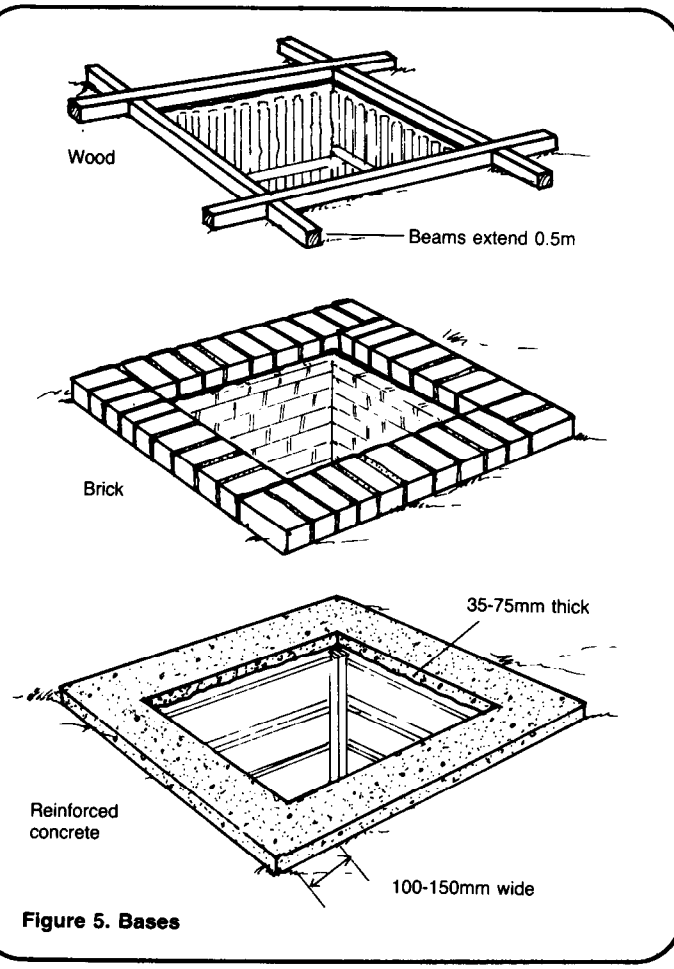


Figure 5. Bases

Labor. Ideally, there should be at least two laborers to dig the pit. If the pit lining or base is wood, one worker should have some carpentry skills; if the lining or base is brick or concrete block, one worker should have some masonry skills; if the base is poured concrete, one worker should have some concrete skills. If this number of laborers is not available, you can certainly make do with fewer. The person in charge of construction should be present during all stages of construction.

Lining. The material used for the lining, if needed, can be bamboo, logs, poles, boards, bricks, concrete blocks, or select field stones. Use a material that is readily available and that laborers are familiar with. The quantity depends on the type of material and the size of the pit. One way to estimate the quantity is to calculate the area of the pit walls, since the lining must cover nearly the entire wall area except for the spaces between the boards, poles, or bricks.

Table 3. Sample Materials List

Item	Description	Quantity	Estimated Cost
Labor	Foreman	1	_____
	Laborers (one experienced with carpentry, stone masonry, or poured concrete, whichever applies)	2 (at least)	_____
Supplies	For laying out the system: wooden stakes or sticks	_____	_____
	For the lining: bamboo, poles logs, boards, bricks, concrete blocks, select field stones	_____	_____
	For the base: wood, bricks, concrete blocks	_____	_____
	For poured concrete or mortar:		
	Cement	_____	_____
	Sand	_____	_____
	Gravel	_____	_____
	Water	_____	_____
	Other	_____	_____
Tools and Equipment	Box or bucket	1	_____
	Sturdy rope or ladder	1	_____
	Measuring tape	1	_____
	Shovels	2 (at least)	_____
	Wheelbarrow	1	_____
	Hammer	1	_____
	Saw	1	_____
	Nails	--	_____
	Trowel	1	_____
	Plumb line (string and rock)	1	_____
	Hatchet or machete	1	_____
	Container (for mixing mortar)	1	_____
	Concrete slab	1	_____
	Other	--	_____

Total Estimated Cost = _____

The area of the pit walls equals two times the width plus two times the length multiplied by the depth (Worksheet A, Lines 16-19).

For example, suppose a pit is 1.1 meters wide, 1.2 meters long, and 2.1 meters deep. Then the area equals:

$$(2 \times 1.1) + (2 \times 1.2) \times 2.1$$
$$= (2.2 + 2.4) \times 2.1$$
$$= 4.6 \times 2.1$$
$$= 9.7 m^2$$

The lining material must cover an area equal to about 9.7 square meters.

Base. The material used for the base can be wood, bricks, concrete blocks, or poured concrete. Use a material that is readily available and that the laborers are familiar with. Figure 5 shows three different types of bases.

(NOTE: A wood base may not last as long as a brick, concrete block, or poured concrete base.)

The quantity depends on the type of material and the size of the pit. One way to estimate the quantity for a brick, concrete block, or poured concrete base is to calculate the distance around the top of the pit. This distance is called the periphery; it is equal to twice the length plus twice the width (Worksheet A, Line 20).

For a base made of bricks or concrete blocks, there must be a sufficient quantity to place the bricks or blocks side by side for a distance equal to the periphery of the pit.

For example, suppose a brick base is needed for a pit 1.1 meters wide and 1.3 meters long. Then the periphery equals:

$$(2 \times 1.1) + (2 \times 1.3)$$
$$= 2.2 + 2.4$$
$$= 4.6m$$

There must be enough bricks to be placed side by side around a periphery of 4.6 meters.

For a poured concrete base, the quantity of poured concrete is equal to the periphery of the pit times the width of the base times the thickness of the base (Worksheet A, Lines 21-23).

For example, suppose a concrete base 0.15 meters wide and 0.05 meters thick is needed for a pit with a periphery of 4.6 meters. Then the quantity of concrete equals:

$$4.6m \times 0.15m \times 0.05m$$

$$= 0.03m^3$$

For a wood base, four logs or sturdy wooden beams are needed, one for each side of the pit. Each log should be 1 meter longer than the side of the pit on which it will be laid, as shown in Figure 5 (Worksheet A, Lines 24-26). For example, suppose a wood base is needed for a pit that is 1.2 meters wide and 1.3 meters long. Then the lengths of the four logs would be:

$$(1.2+1.0),(1.2+1.0),(1.3+1.0),(1.3+1.0)$$

$$= 2.2m, 2.2m, 2.3m, 2.3m.$$

Tools. The tools required will vary according to the type of pit lining and base. All types of pits require at least two shovels (one per laborer) or other digging implements. A wheelbarrow is useful for carting away excavated dirt and for bringing other material to the pit site. A saw and nails are needed if the lining or base is made of wood, logs or boards. If the lining or base is made of bricks or concrete blocks, or the base is made of poured concrete, a container for mixing the concrete or mortar and a trowel for applying and smoothing concrete or mortar are needed.

Also needed are a measuring tape to help determine the exact location of the pit, and wooden stakes or sticks to lay it out on the ground. A plumb line (long string with a rock tied to the end) will be useful to ensure that the pit walls are dug vertically. A sturdy rope or ladder should be available for the laborers to get into and out of the pit.

Cost. The cost of the pit depends on a number of variables: which materials are available and which must be purchased; how much labor will be volunteered and how much must be paid for; prices and wage rates; and so on. Make your best estimate based on local conditions.

When all calculations, determinations, and estimates have been made, prepare a materials list similar to Table 3, and give it to the construction supervisor. In summary, give the construction supervisor: (1) a location map similar to Figure 1, showing the location of the pit in relation to all nearby structures and geographical features; (2) a technical drawing similar to either Figure 2 or Figure 3, depending on the type of pit privy, showing correct dimensions of the pit; (3) sketches similar to those in Figure 4 and Figure 5, showing the general configuration of the pit lining and base; and (4) a materials list similar to Table 3 showing the labor, materials, tools, and money needed to construct the pit, lining, and base.

Technical Notes are part of a set of "Water for the World" materials produced under contract to the U.S. Agency for International Development by National Demonstration Water Project, Institute for Rural Water, and National Environmental Health Association. Artwork was done by Redwing Art Service. Technical Notes are intended to provide assistance to a broad range of people with field responsibility for village water supply and sanitation projects in the developing nations. For more detail on the purpose, organization and suggestions for use of Technical Notes, see the introductory Note in the series, titled "Using 'Water for the World' Technical Notes." Other parts of the "Water for the World" series include a comprehensive Program Manual and several Policy Perspectives. Further information on these materials may be obtained from the Development Information Center, Agency for International Development, Washington, D.C., 20523, U.S.A.

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